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THE CLIMATE OF ANCIENT PALESTINE.

BY

ELLSWORTH HUNTINGTON.

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THE PRESENT CLIMATE AND RELIEF OF PALESTINE.

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TYPES OF EVIDENCE AS TO CHANGES OF CLIMATE.

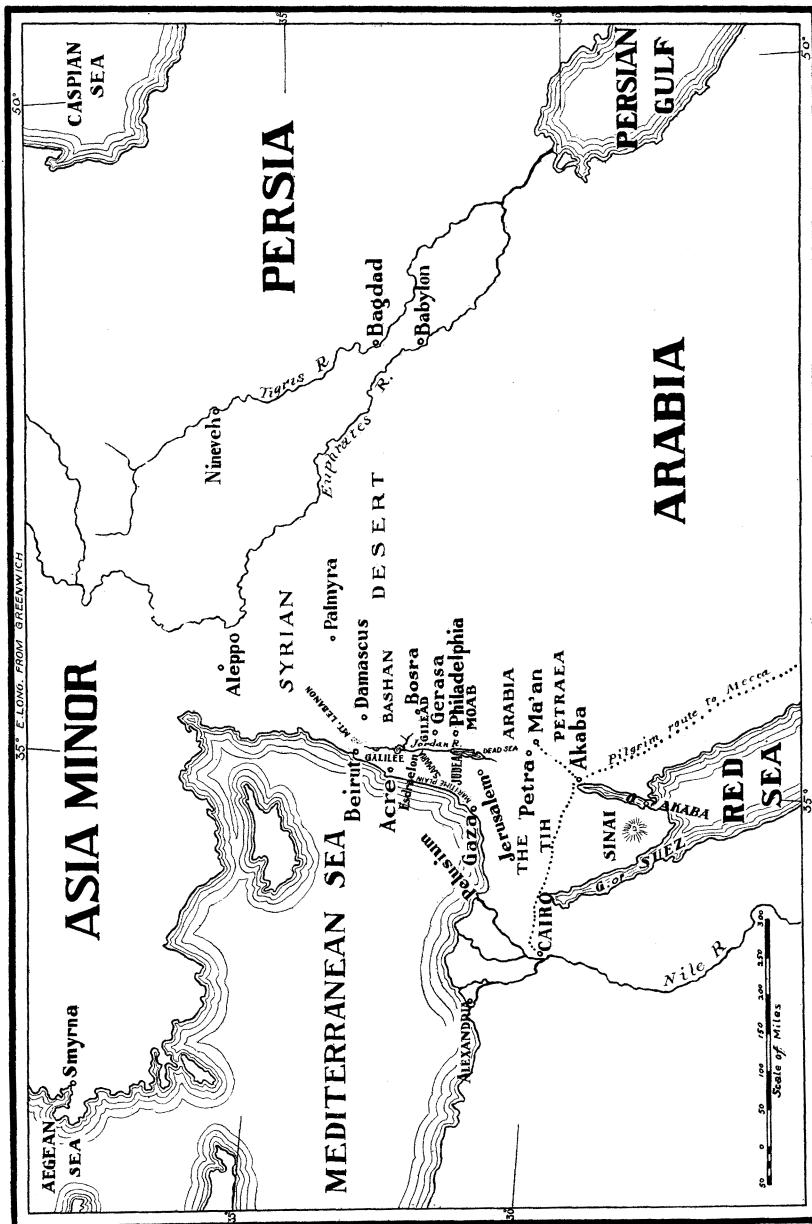
- (1) The Population of Ancient Palestine.
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Since Palestine became an object of scientific study a century or more ago, there has been much discussion as to the climate of the country in ancient times. Some writers assert that during the last two or three thousand years climatic conditions have changed greatly. To this, primarily, they ascribe the present poverty-stricken condition of the country. Others, with equal positiveness, declare that such a change is impossible. There is nothing, they say, which demands such an hypothesis: the decay of Palestine and of the neighbouring countries is clearly due to human greed, misgovernment and folly. Among those who have believed in changes of climate are Livingstone,\* who wrote down his conclusions upon the subject during an enforced halt on his last great journey in Central Africa; Reclus, whose knowledge of the geography of the world as a whole has rarely, if ever, been surpassed; Fraas, Hull, Fischer, and others. On the contrary side may be ranged the names of Ankel, Conder, Hilderscheid, and Wilson, all of them able thinkers. Some authors, as might be

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\* A list of references will be found at the end of the concluding part of this article.



MAP OF SYRIA AND SURROUNDING COUNTRIES.

expected, are in doubt. Lartet, for instance, first declared his belief in climatic changes, and later qualified it by declaring that although such changes may have occurred, the main cause of the decay of Palestine is to be found in the foolish conduct of man. He does not consider the question of the degree to which such conduct may have been caused or favoured by adverse physical conditions. On the whole, the weight of authority, so far as numbers are concerned, lies with those who believe in changes of climate. The majority of the most recent writers, however, incline to the contrary belief.

The present diversity of opinion may be ascribed largely to three causes. In the first place, little attention has been paid to the subject by the students of history or anthropology, because the geographers and meteorologists who have discussed the question have rarely pointed out the influence which changes of climate may have exerted upon the habits, industries, prosperity, and political condition of a people. In the second place, writers upon the subject, especially those who do not believe in climatic changes, have laid the weight of emphasis upon the most prosperous part of Palestine, namely the central plateau embracing Judea, Samaria and Galilee. Even to-day this part of the country enjoys a moderately favourable climate. If the rainfall were increased, say thirty per cent., it would doubtless be a great advantage in Galilee, for example; but it would make nothing like so great a change in the conditions of human life as would a similar increase of thirty per cent. in the precipitation of the drier regions of the Tih and Arabia Petræa to the south and southeast of Judea. It is in the peripheral regions, rather than in the centre of Palestine that the chief evidence of climatic changes is to be expected. Finally, a third great cause of the present diversity of opinion as to the ancient condition of Palestine is found in the fact that the attention of students has been directed chiefly to matters where positive conclusions can scarcely be expected, while some of the most important lines of evidence have hardly been touched. Much has been made of the fact that the Bible and other ancient accounts speak of Palestine in a way implying that it was once much more fertile than is now the case. Many attempts have been made to show that in the past the rate of increase of the staple crops was greater than at present, and that plants were cultivated which will not now grow in Palestine. All these lines of argument are interesting and important, but, as Ward and others have shown, they are inconclusive. They depend largely upon human factors which may work either with or against the forces of nature. Man may foster a special crop from mere caprice; he may speak with undue extravagance of the

fertility of his boyhood home; or he may use terms such as desert, drought, and brook with a merely relative significance. To the inhabitant of Arizona these words bear a meaning quite different from that with which they are used by the Englishman. Accordingly, in the discussion of the ancient climate of Palestine it is necessary to eliminate the human factor so far as possible, or at least to appeal to kinds of evidence where the part played by man can be estimated with a fair degree of accuracy.

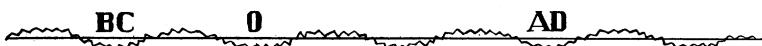
The question of changes of climate in Palestine possesses a two-fold importance. In the first place, it has a most vital bearing upon the fascinating subject of biblical history and interpretation. The accounts of the Exodus; the stories of the Assyrian conquests and of the commerce of Solomon; and the records of the intercourse of Egypt and Syria, and of the populousness and fertility of Palestine in the time of Christ, are all subject to very different interpretations according to whether we accept or reject the theory of climatic change. If the theory be rejected, a choice must be made between two horns of a dilemma. It is necessary either to accept the view of a certain school of critics who hold that a large number of the biblical authors indulged in undue hyperbole; or else to hold with the old-time theologians that in the ancient days God interrupted the course of nature in favor of the Chosen People. If the theory be accepted, a large number of narratives which to many persons now seem improbable become perfectly reasonable.

The second reason for the importance of the study of the climate of ancient Palestine is that the country furnishes, perhaps, the best of all keys to the climatic history of the whole ancient world. Its central position, and the accuracy with which its history is known for 3,000 years, make it possible to use the country as a standard by which to test conclusions as to regions whose history is less well known, or whose climate is such that the effects of change are less apparent. Lying, as it does, on the border between the great desert tracts of Asia and the better-watered countries of the Mediterranean, its climate shares that of both regions. A slight change would have marked effects, especially upon:

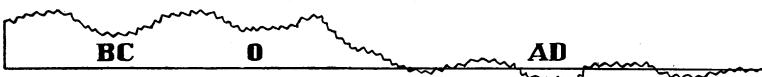
"The narrow strip of verdure sown  
Which just divides the desert from the sown."

If it be true, as a principle, that, in the regions once occupied by the ancient empires of Eurasia and northern Africa, unfavourable changes of climate have been the cause of depopulation, war, invasion, migration, the overthrow of dynasties, and the decay of civilization; and if favourable changes have made it possible for nations to

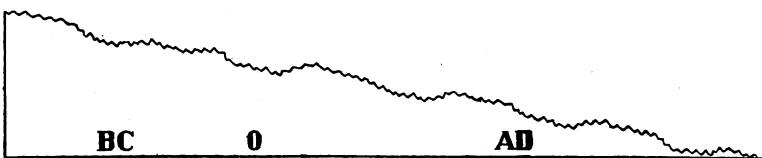
expand, grow strong, and develop the arts and sciences, Palestine and the surrounding country of Syria ought to show evidence of this as plainly as almost any part of the world. Their history should present a close correspondence between climatic fluctuations on the one hand, and economic, social, and political events on the other. Before the existence or non-existence of any such relation between climate and history can be proved it is necessary first to determine conclusively whether changes of climate have actually taken place; and then to ascertain the extent and nature of the changes and the times at which they have occurred. The purpose of this paper is to present certain facts which bear upon this problem and which indicate its great importance in the study of history.



**FIGURE 1. HYPOTHESIS OF UNIFORMITY**



**FIGURE 2. HYPOTHESIS OF DEFORESTATION**



**FIGURE 3. HYPOTHESIS OF PROGRESSIVE CHANGE**



**FIGURE 4. HYPOTHESIS OF PULSATORY CHANGES**

**CLIMATIC HYPOTHESES.**—In the discussion of the climate of ancient Palestine four hypotheses have been advanced. They may be graphically represented by the accompanying diagrams. The horizontal line in each case represents the course of time from the past to the present, the left-hand end denoting a period some three thousand years ago near the beginning of well-known history. The height of the curves above or below the horizontal line indicates the departure of the climate at any given time from the climate of to-

day. An upward curve represents increasing precipitation or falling temperature, or both; a downward curve indicates diminishing precipitation or rising temperature, or both. In other words, high points on the curves betoken relatively cool, damp conditions, and low points warm, dry conditions. In each diagram the line representing the course of climate from past to present is wavy. This is designed to represent the fact that the climate of all parts of the world is subject to variations. It is well known that the climate of a given region, especially in the temperate zone, is characterized at some times by a series of dry or warm years, and at other times by a series of wet or cold years. These variations seem to fall in cycles, the best known of which is the 35- or 36-year cycle of Brückner. There are indications of other cycles having lengths of 3, 11, and 300 years, but these are as yet open to some question.

HYPOTHESIS OF UNIFORMITY.—Figure 1 represents what may be called the uniformitarian hypothesis. According to it, during historic time there has been no marked alteration in the climate of Palestine or any other part of the world. The only changes have been those pertaining to the various cycles mentioned in the last paragraph. The climate of a given place may change a little for a few years, but it always comes back to a certain norm. The changes of the historic past are like those of the present with no essential difference either in kind or degree. The best exposition of this view, as applied to the world as a whole, is found in an article by Ward in the *Popular Science Monthly* for November, 1906. While not absolutely excluding the possibility of great climatic changes, he holds that there is no sufficient proof of their occurrence. He gives forcible reasons for believing that a large part of the supposed evidence of change is either untrustworthy, or is easily explicable as the result of the minor changes of the short cycles, especially the 35-year cycle. The uniformitarian hypothesis is largely held by meteorologists. They see that there is no foundation for the current idea that the climate of America or Europe has changed appreciably during the last few score years. They see also that since the beginning of meteorological records there are only very faint indications of permanent changes in temperature, rainfall, and barometric pressure. Knowing how easy it is to make mistakes in the exposure and reading of instruments, they believe that the few indications of change which appear from the compilation of records are the result of error, as many of them undoubtedly are. Meteorologists are thus rendered very sceptical as to all changes of climate, whether past or present.

HYPOTHESIS OF DEFORESTATION.—The second figure represents perhaps the commonest of all views as to the climate of Palestine. Many travellers go to the East, and see there what seem to them to be strong indications of a marked change of climate. Having heard much as to the great havoc wrought by the destruction of forests, and finding that where there are forests there is more rain than elsewhere, they jump to the conclusion that the forests "draw" the rain. Certain authors, for example Anderlind, utterly ignore the possibility that the reverse is true, and that the greater abundance of rain causes the forests. There can be no doubt as to the harmful results of deforestation upon the flow of rivers and upon the washing away of the soil. The only question is whether so small a feature as a forest can appreciably affect the amount of rainfall. The many persons who hold this theory believe that Palestine was once well wooded and somewhat more rainy than it now is. Then the forests were cut off, and the climate deteriorated to its present condition.

HYPOTHESIS OF PROGRESSIVE CHANGE.—The exponents of the third hypothesis assume that a change of climate has taken place; but, unlike those who believe in the second hypothesis, they usually make no attempt to explain its cause. They point to a body of facts which seem to them to indicate that in the past there was much more water in Palestine than now. Since the time of Christ, they say, the fertility, habitability, and general prosperity of the country have declined to a greater degree than could possibly result from deforestation or from human negligence and folly. Geologists are especially prone to this view. They find unquestionable evidence that during the glacial period Palestine enjoyed a climate very different from that of to-day. The Dead Sea expanded so as to fill most of the Jordan Valley, as is proved by elevated strands; and glaciers existed upon Mt. Lebanon, as appears from old moraines. The remains of prehistoric man are found in caves with leaves of northern trees such as the oak and maple of Central Europe, and with the bones of animals whose habitat is far to the north. Therefore, the geologists are apt to assume that the change from the climatic conditions of the glacial period to those of to-day has been gradual, and that it has lasted well down into historic times.

HYPOTHESIS OF PULSATORY CHANGES.—The last hypothesis, that of pulsatory changes, represented in Figure 4, is an attempt on the part of the author to harmonize two groups of facts part of which agree with the uniformitarian hypothesis (Fig. 1), and part with the hypothesis of progressive change (Fig. 3). That is, there seem to

be some facts indicating strongly that conditions like those of to-day existed one or two thousand years ago; while other equally salient facts apparently point to greater rainfall or lower temperature in the past than in the present. The only way to explain the two sets of facts seems to be by supposing that the climate of Palestine and other countries has been subject to fluctuations of considerable amplitude, although on the whole the tendency has been toward warmth and aridity.

THE PRESENT CLIMATE AND RELIEF OF PALESTINE.—The two fundamental facts which determine the nature of the climate of Palestine are, first, the location of the country in reference to the great climatic zones of the earth as a whole, and, second, its location in reference to the Mediterranean Sea. These, in conjunction with the relief of the land, give Palestine a peculiar climate. The great extent of the land-mass of Asia and the high degree to which it becomes heated under the rays of the summer sun cause all the climatic zones in that part of the world to be strongly deflected northward. Palestine lies normally in the zone of prevailing westerly winds where rain is supplied more or less abundantly by cyclonic storms of large dimensions moving for thousands of miles from west to east. During the summer, however, this zone is deflected so far to the north, that its place is taken by the rainless subtropical zone of dry descending air, or by a modified form of the trade-wind belt, where the winds blow prevailingly from a northeasterly quarter. In the case of the zone of descending air there is no rainfall, because, as the air comes down, it becomes warmer, and hence relatively drier, so that it absorbs moisture instead of giving it up. In the case of the modified trade-winds, if the air comes to Palestine from the east it has blown over the dry interior of Asia, and has had no opportunity to collect moisture. If it comes from the north, it has had scarcely better opportunities to collect moisture than if it came from the east, and it is also moving into warmer regions, where its capacity for holding moisture increases, and it, of course, gives up no rain. Thus it happens that Palestine has a long dry season from April to October, and a rainy season during the other half of the year. During the rainy season the prevailing winds blow from the west. Having come across the Mediterranean Sea, they are abundantly charged with moisture. When they reach Palestine the relief of the land causes them to rise rapidly. Hence they are cooled, and discharge their moisture in abundant showers. During the winter a large portion of Palestine has quite as much precipitation as most

parts of England or of the eastern United States. There is a little snow, but far the larger part of the moisture comes as rain.

Palestine is divided into regions of two sharply contrasted topographic forms,—plateaus and plains. The chief cities and the densest population, contrary to what is the case in most countries, are situated upon the plateaus. The plains are well populated, but they have always been of relatively small importance in history. They are three in number, the maritime plain along the Mediterranean coast, where the Philistines once dwelt; the low, warm plain of the Jordan Valley; and the plain of Esdraelon, running from west to east and connecting the other two a little south of the Sea of Galilee. The plateaus consist of Galilee, Samaria, and Judea in order from north to south on the west side of the Jordan, and Bashan, Gilead and Moab from north to south on the east side of the Jordan. The plains are rich now, even as they have always been. They can be irrigated by means of the streams which come from the plateaus. In the past, irrigation does not appear to have been of great importance, but year by year it is assuming a more prominent place in the economic development of the country. The plateaus cannot be irrigated except in occasional places where the water of a spring can be led along the hillside to an orchard or vineyard. For staple crops such as wheat and barley, which occupy a large area, extensive irrigation is impossible. Now, as always, the plateaus depend upon "the rain of heaven." The people store it up in cisterns for the use of themselves and their cattle during the long dry summers, and trust the efficiency of prayer to supply a due amount for the crops in the late fall and early spring. The plateaus, where the strength of Palestine has always resided, are the parts of the country most sensitive to a diminution of rainfall.

**NATURE OF THE SUPPOSED CHANGES OF CLIMATE.**—In considering the four theories of climatic change set forth above, it must not be supposed that the changes demanded are of a very radical nature.

During historic times there has doubtless always been a wet, rainy season in winter, and a long dry season in summer. The most that is assumed is that the rainy season may have been somewhat longer and moister than at present, with a greater number of days upon which rain or snow fell; summer storms, which are now very rare, may have occurred fairly often; and the mean temperature of the year or of the winter may have been lower than is now the case. Such changes, even though slight, would have a great effect upon the habitability of the country. Geologists and physicists who have made a special study of the glacial period have come to the conclu-

sion that a diminution of from  $10^{\circ}$  to  $15^{\circ}$  C., or  $18^{\circ}$  to  $27^{\circ}$  F. in the mean temperature of Europe or America would suffice to cause a recurrence of glacial conditions such as those through which the earth has recently passed. It would cause the United States to be covered with ice down to Long Island and Cincinnati, and would make a large part of the rest of the country as uninhabitable as northern Canada now is. This being so, it is clear that a change of from  $3^{\circ}$  to  $5^{\circ}$  F. in the mean annual temperature of Palestine, with corresponding changes in precipitation and evaporation, would have a marked effect upon the habitability of the country.

The most serious disadvantage in the climate of Palestine to-day is not lack of rain. From 1860 to 1906 the average precipitation at Jerusalem amounted to over 26 inches per year, which is about the same as that of the State of Minnesota. Practically all the rain, however, comes in the colder half of the year, when it is of little use for vegetation. Of the total amount of 26 inches, 25.5 inches falls during the six months from November to April inclusive, and 21.5 inches in the four months of December, January, February and March. From May to October inclusive there is almost no rainfall, and April has but little. The seasonal distribution of rain in Palestine much resembles that in central California, although the rainy season in the Asiatic country is somewhat shorter than in the American State. Santa Cruz, near Monterey, on the coast a little south of San Francisco, is one of the雨iest places in California outside of the high Sierran region. It had an annual precipitation of 26.8 inches from 1873 to 1903. Of this amount, 23.3 inches fell during the six months from November to April inclusive, as against 25.5 in Jerusalem, while 18.3 inches fell in the four months from December to March, as against 21.5 at Jerusalem. It thus appears that the rainfall of Jerusalem is very much like that of Santa Cruz, although more concentrated during the winter months.

In Palestine, if the rains at either end of the rainy season, the "former" and "latter" rains, do not come at the expected time or are not sufficiently heavy, the crops fail more or less completely. Hence, a slight lengthening of the rainy season would be of very great value in giving assurance of moisture enough for at least moderate crops. If the winter temperature were lower, it would also be a great advantage. Where the winter precipitation takes the form of rain, as it usually does in Palestine, much of the water runs off, and there is danger that the ground may not become completely soaked. If the precipitation takes the form of snow, this melts gradually and the ground becomes thoroughly saturated. The spring rains serve

to keep the surface wet. Thus, when the rainy season comes to an end, there is a large body of underground water to support the growth of plants, especially of trees which require water late in the season, and to sustain the flow of springs and other sources of water for irrigation. It would, therefore, be a very great advantage to Palestine if the winters were a few degrees colder, so that snow fell more abundantly and stayed longer than now, and if the rainy season were a little longer, so that there would be less danger of drought in the critical seasons of fall planting and spring growth.

In the following pages it must be borne in mind that it is a change of this sort which is postulated. One writer compares the climate of ancient Palestine to that of England to-day. Such a comparison is misleading. It involves a complete change in the regimen of the seasons. If the climate of Palestine during historic times were ever different from what it is to-day, it probably resembled that which would now prevail along the Ægean coast of Asia Minor if the relief of the land and its relation to the sea were like those of Syria.

*(To be continued.)*

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## THE HUMAN SIDE OF SYSTEMATIC GEOGRAPHY.

BY

WALTER SHELDON TOWER, PH.D.

The scientific study of any complex subject in its varied branches depends on the recognition of two fundamental principles: first, the determination of the scope of the subject, and, second, the adoption of some logical method of treatment. In the case of geography, at the present time, the scope of the subject is admittedly the study of the earth in its relation to life. By this definition geography is made to cover the entire field of studying and analyzing every type of land form and the way in which each type controls, modifies, or prohibits entirely animal and plant life in that region. Theoretically, these two correlated aspects of earth study stand on exactly the same plane, neither being subordinate to the other. If either aspect may be said to outweigh the other, a strict interpretation of the definition would seem to make the life element the important point, since earth study becomes geography only when it is considered *in its relation to life*. Taking man as typical of life in general, the definition might